

Improving Jet Resolutions

Motivation

Physics Effects

Definitions of Resolution

Optimum Use of All
Detector Information

Testing New Algorithms
With Collider Data

Motivation

- Improve mass resolution for Higgs and New Physics searches (and Top?)
- Sharpen Jet and Missing Et cuts to improve signal/background ratios (most relevant for Top?)
- Use the extended tracking of the Run II detectors
- Reduce pileup effects by selecting tracks only from the primary collision vertex
- Do the best we can...

Physics Effects

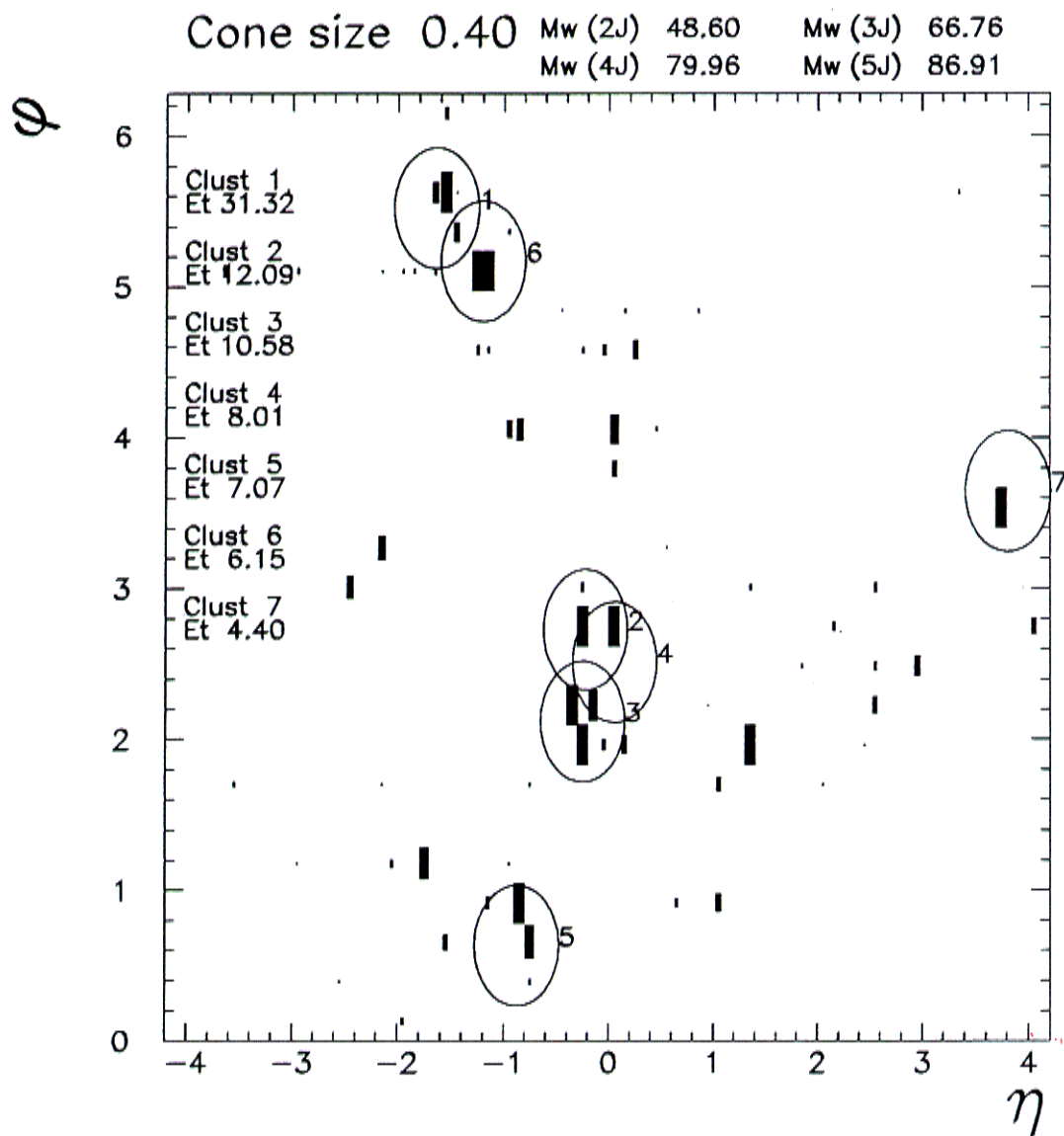
Large-Angle Final State
Gluon Radiation

Initial State Gluon Radiation

Underlying Event Fluctuations

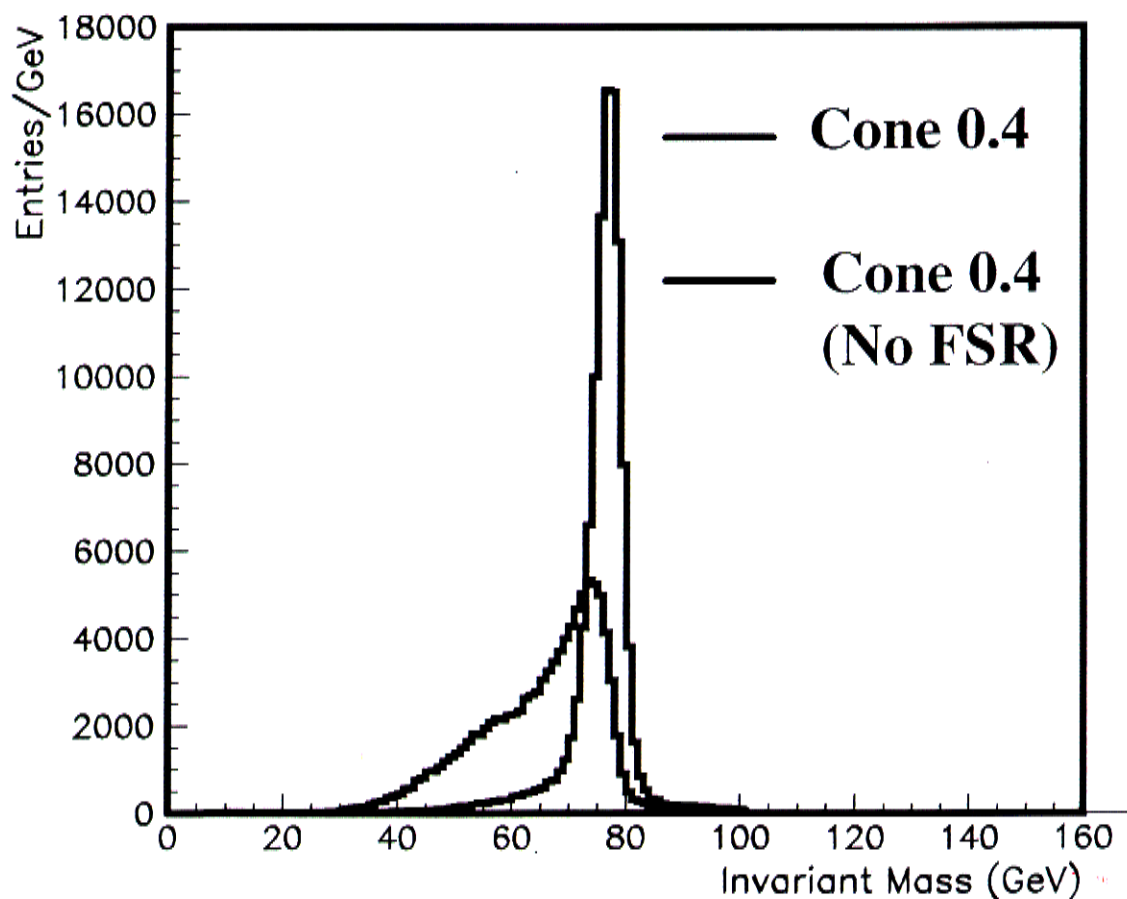
Neutrinos from
Heavy Quark Decays

W Event as an Example of Gluon Radiation Effects



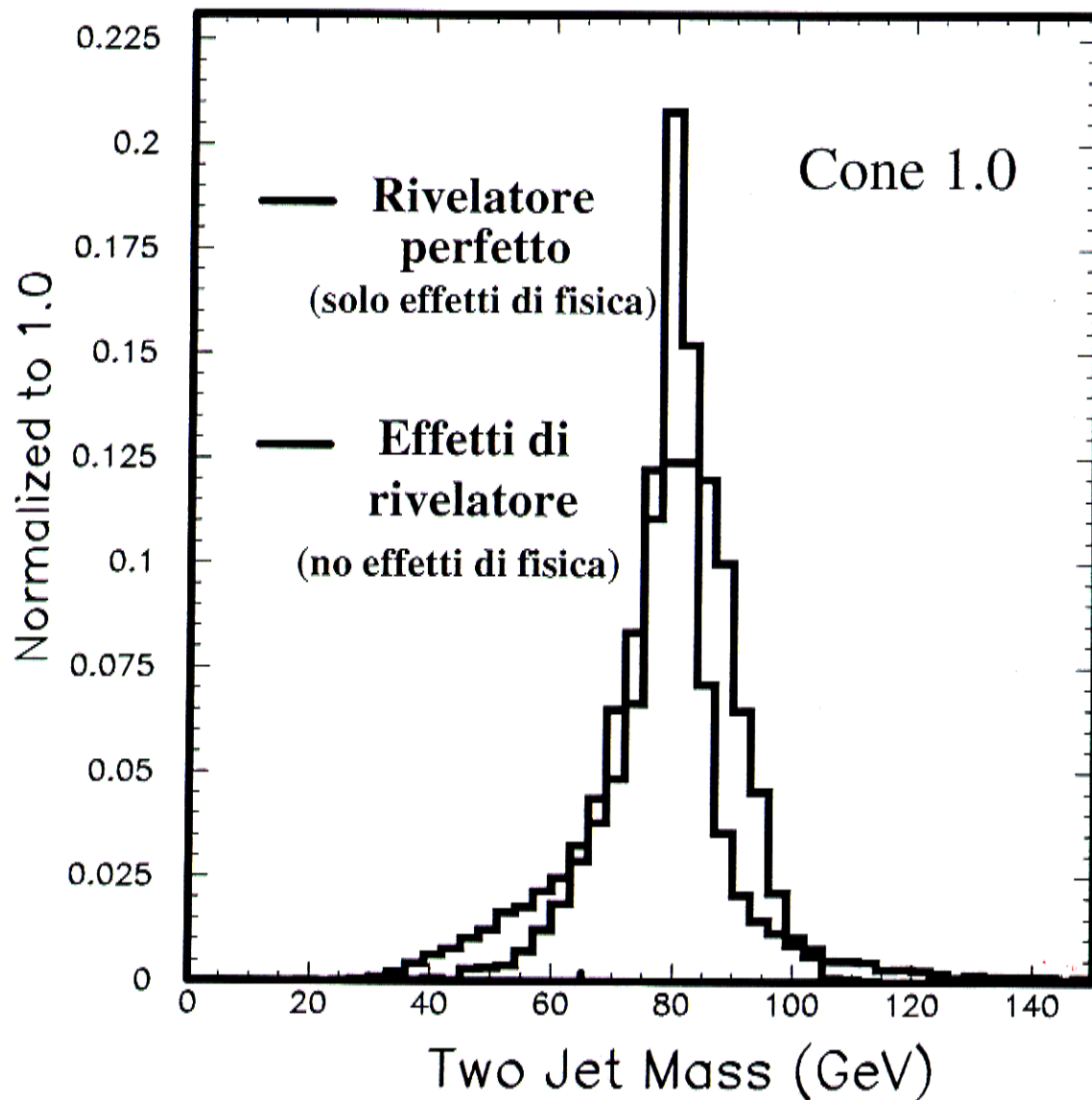
Main Physics Effect is Due to Final State Gluon Radiation

$W \longrightarrow 2 \text{ jet}$ (PYTHIA)



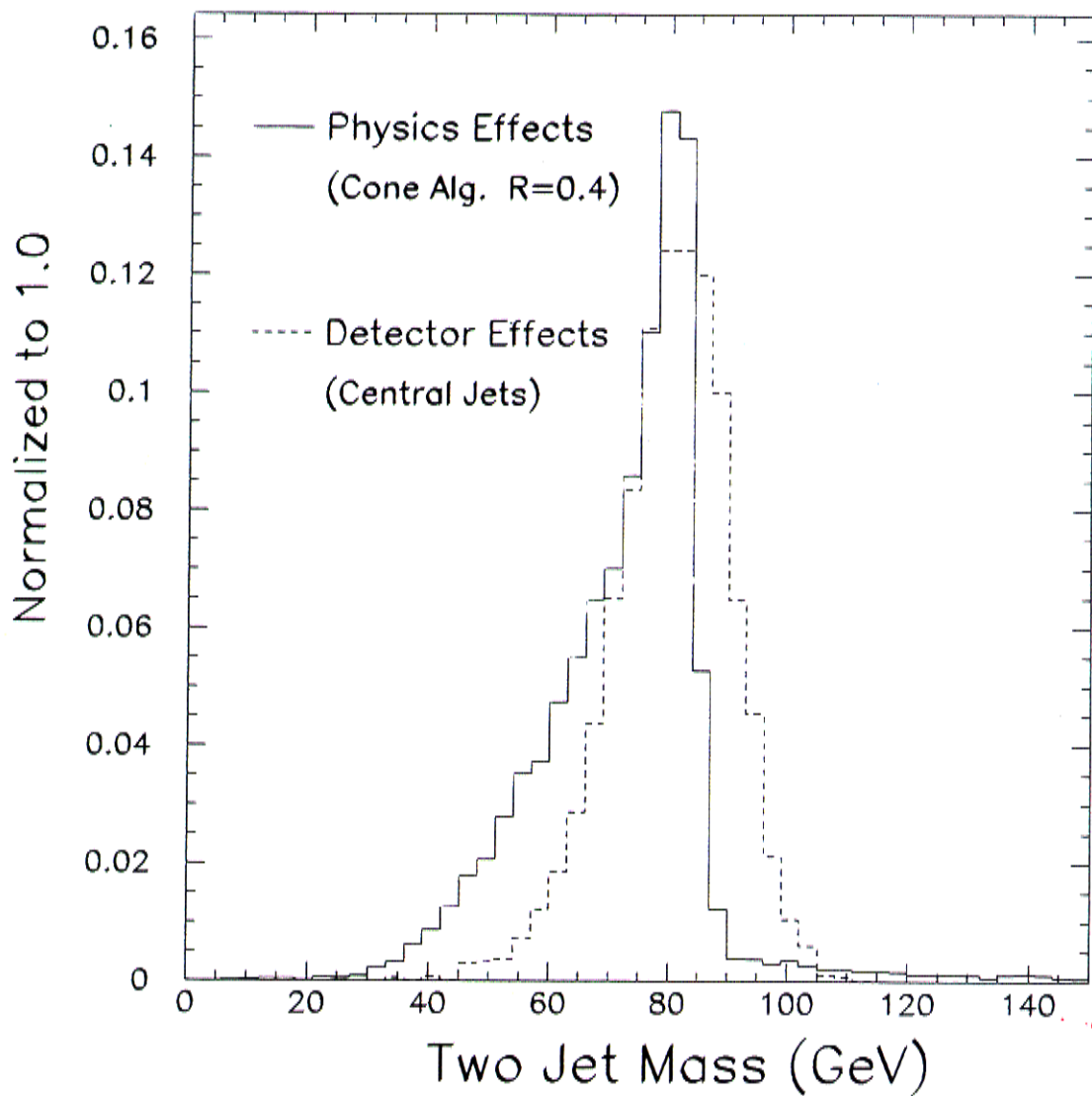
Comparison of Pure Physics Effects and Pure Detector Effects

$W \rightarrow 2 \text{ Jet}$ Simulation



Same But With Cone 0.4

$W \rightarrow 2 \text{ Jet Simulation}$



Strategies to Handle Gluon Radiation (other than extra jet cuts)

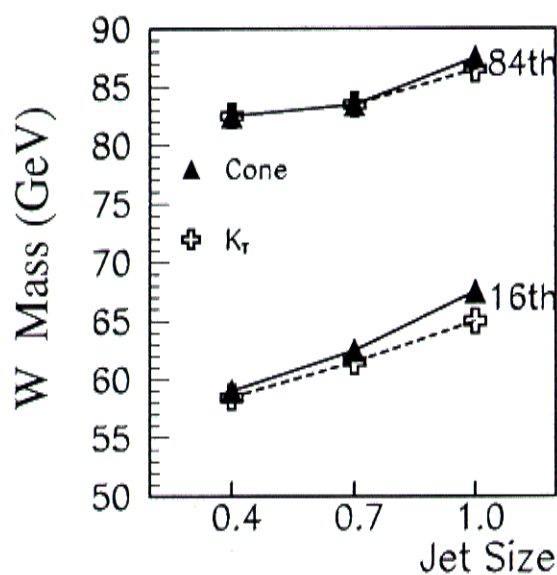
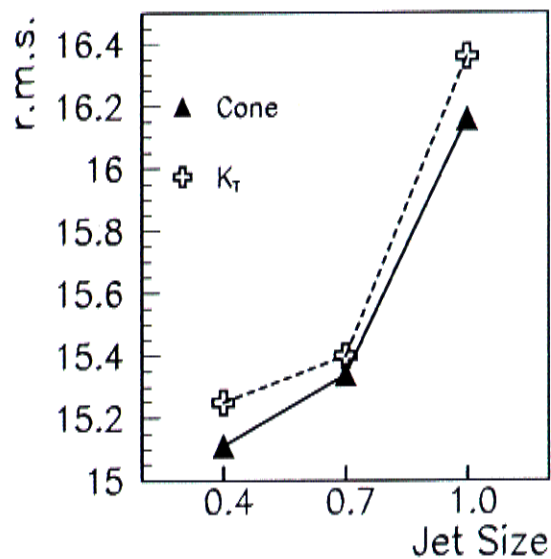
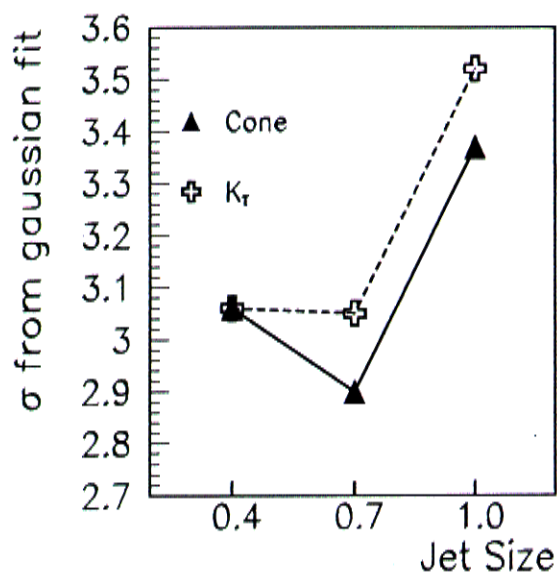
Optimized Cone Size

K_t vs Cone Algorithm

Optimized Merging Criteria
of Cone Jets

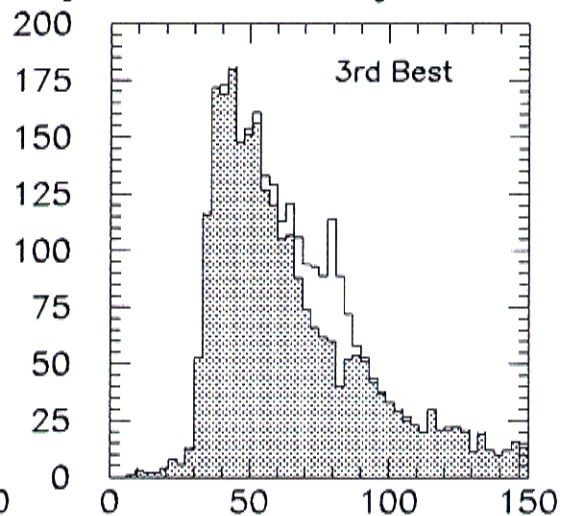
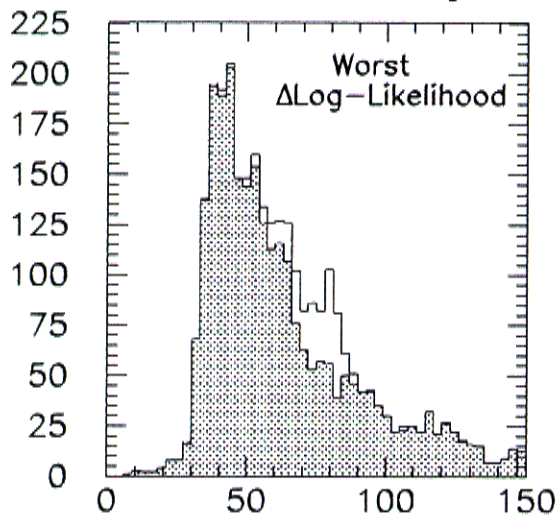
Not Even Easy to Define
the Best Answer

Definitions of Resolution



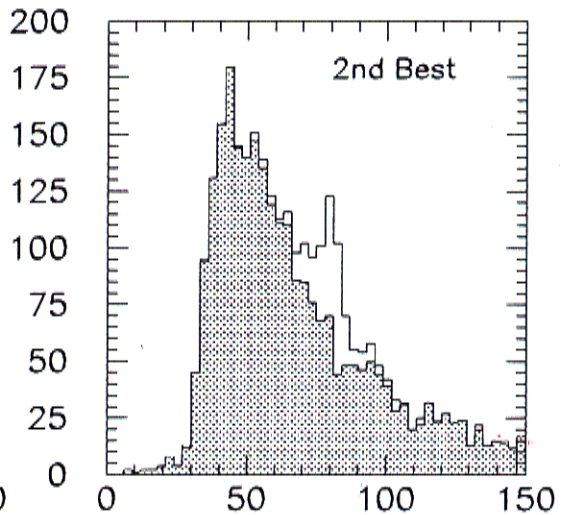
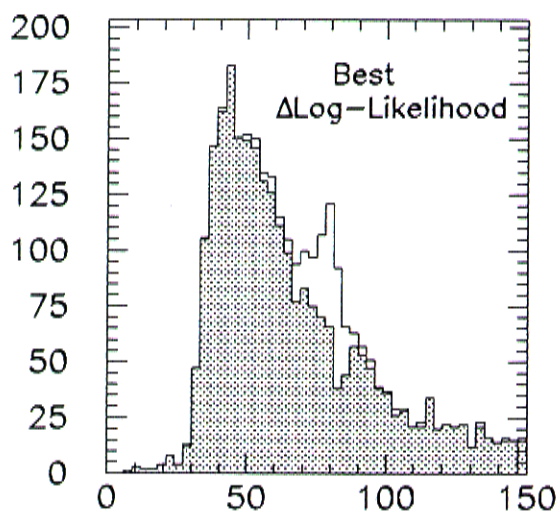
Full Signal to Background Study Says Merging Within Radius 1.0 Best

PYTHIA W \rightarrow 2 Jet Signal + Background With Cone 0.4 Algorithm



Two Jet Mass (No Merging)

Two Jet Mass (Merged $R=0.7$)



Two Jet Mass (Merged $R=1.0$)

Two Jet Mass (Merged $R=1.3$)

Implications for Top

Radius 1.0 obviously too large for Top, as separation of signal and background suffers.

Perhaps a more sophisticated merging criteria, such as cutting on the ratio of jet p_t , could be applied first.

(has a detailed study been done?)

Optimum Use of Detector Information

Run I jets measured with
calorimeters only

Average track pt in a 50 GeV jet
is 4 GeV (eg. from a 115 GeV Higgs)

Tracking resolution for 4 GeV
track is about 0.5%, while
calorimeter resolution is 20-30%.

Optimum Use of Detector Information

Using tracks allows the
possibility of reducing jet pileup
from other collisions by
(naively) $\times 3$

Preshower detectors used in
ZEUS give 17% improvement
(talk by Magill at CALOR2000)

Shower Maximum detectors
useful in tagging photons in jet

Optimum Use of Detector Information

Many other possibilities:

muon hits for leakage estimate

soft lepton and vertex
information for b jets

phototube ratios

...


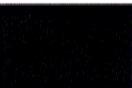






The diagram illustrates three types of calorimeter towers and their internal structure:

- Track Towers:** Consist of a central **(target)** region flanked by **(leakage)** regions. A **Charged Particle** track is shown passing through the central target region.
- Gamma Towers:** Consist of a central **(target)** region flanked by **(leakage)** regions. A **Photon** is shown interacting in the central target region.
- Mixed Towers:** Consist of a central **(target)** region flanked by **(leakage)** regions. Both a **Charged Particle** track and a **Photon** are shown interacting in the central target region.

The diagram also shows the internal structure of the calorimeters, which are divided into three layers:

- Hadronic Calorimeter (HAD):** The top layer, represented by a grid of horizontal lines.
- Electromagnetic Calorimeter (CEM):** The middle layer, represented by a grid of horizontal lines.
- Strip Chambers (CES):** The bottom layer, represented by a grid of horizontal lines.

Breakdown of Tower Types For 25-50 GeV Jets

	Tower Fraction	Energy Fraction
Track	 58.6%	 31.0%
Gamma	 8.8%	 7.9%
Mixed	 17.8%	 57.8%
N. A.	 14.8%	 3.4%

How to Test New Algorithms on Run I/II Data?

No Perfect Way to Do This

$W \rightarrow q \bar{q}$ in Top Events
(9 Double-Tagged Events in Run I)

Present $Z \rightarrow b \bar{b}$ Signal
(Very biased Sample)

$Z \rightarrow b \bar{b}$ Signal in Run II With
Silicon Trigger (Fine if it Works)

How to Test New Algorithms on Run I/II Data?

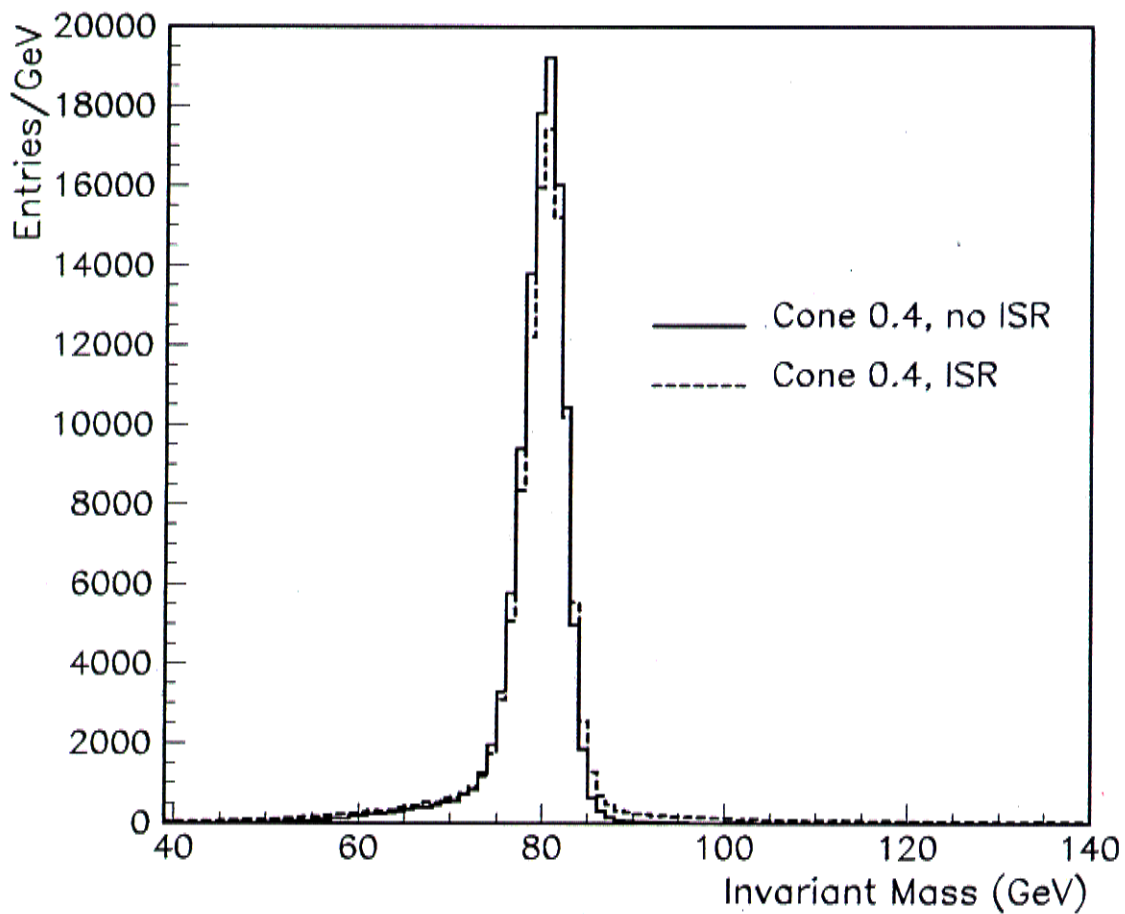
Other Methods Involve Pt Balancing
of Two Back-to-Back Objects

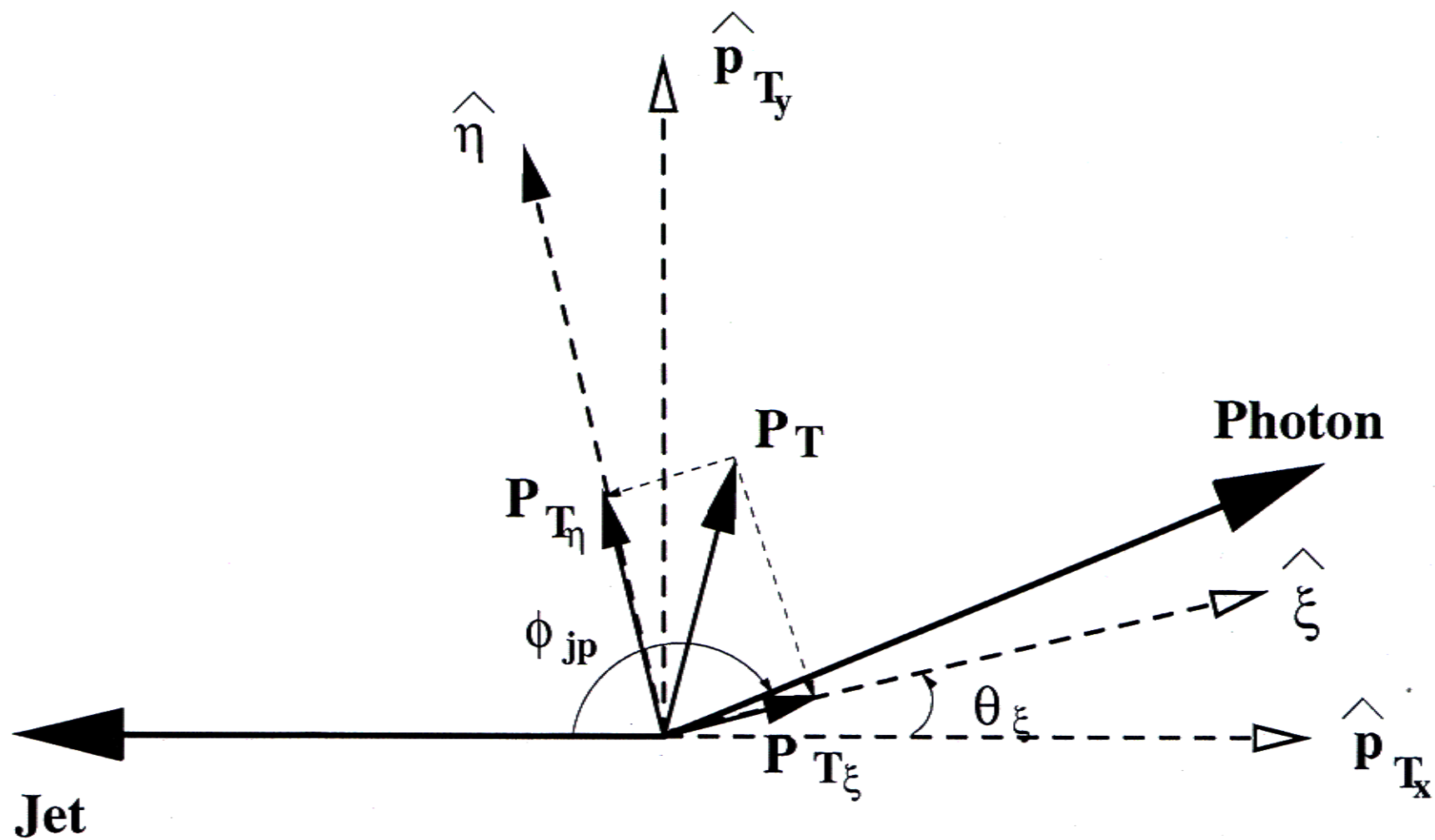
QCD Production of Dijets Best For
Jets Above 150 GeV, But Main
Interest is In Lower Pt Jets

For Now Use QCD Production of
Direct Photon + Jet Events

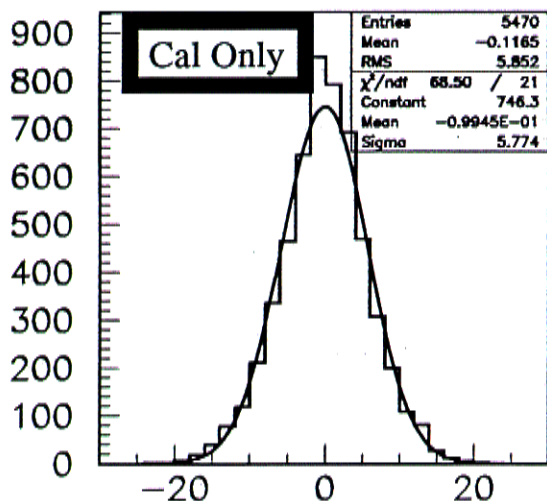
Initial State Radiation is a Significant
Problem in Any Pt Balancing Method

ISR Has a Significant Impact on Pt Balancing Test, But is Not Important For Dijet Mass

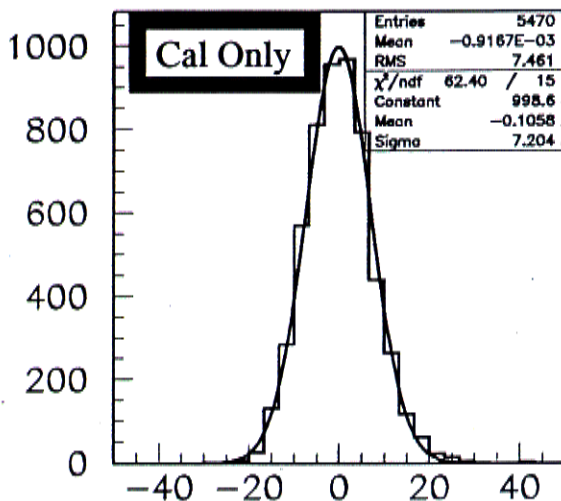




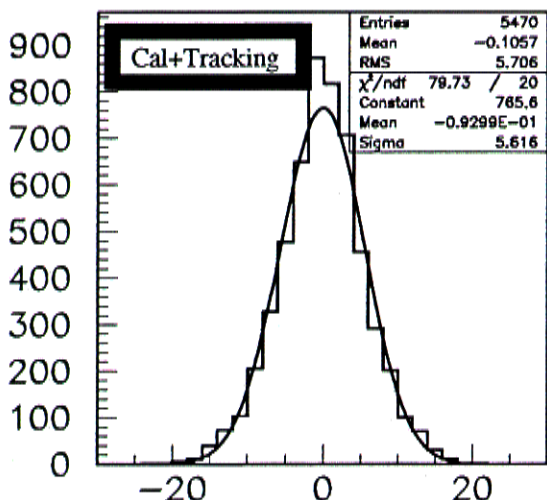
Photon+Jet Events (25-30 GeV)



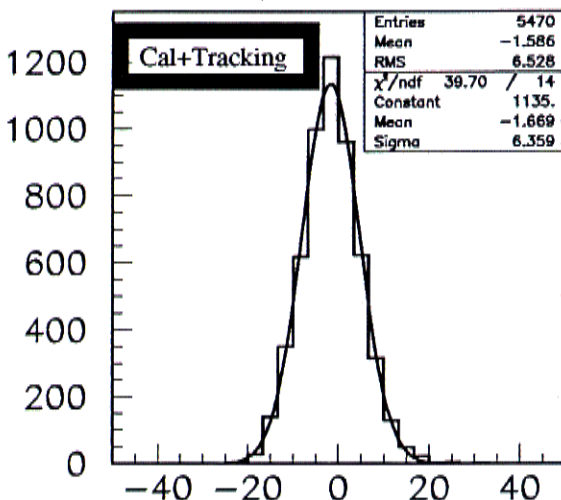
Pt η (GeV)



Pt ξ (GeV)



Pt η (GeV)



Pt ξ (GeV)

Conclusions

Potential Exists to Improve Jet
Resolutions Beyond the
Run I Top Analyses

Could Impact the
Top Mass Resolution,
Signal/Background Ratio,
and Reduce the Luminosity
Dependence Due to
Multiple Vertices